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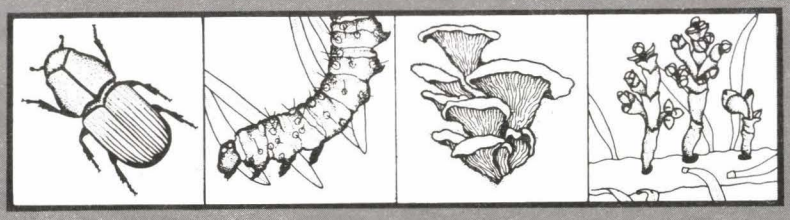

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MORTALITY OF CONTAINERIZED WESTERN LARCH SEEDLINGS AT THE CHAMPION TIMBERLANDS NURSERY, PLAINS, MONTANA

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ABSTRACT

Causes of mortality of containerized western larch seedlings at the Champion Timberlands Nursery, Plains, Montana, were investigated. Seedlings were rated for disease severity based on extent of foliar decline symptoms and fungal isolations made from their roots. Isolations were also made from selected larch seed. Consistent associations between root colonization by potentially pathogenic fungi and level of disease symptoms were not found. Fusarium spp. were only isolated from a few seeds and seedlings sampled toward the end of the growth cycle. These fungi were also frequently isolated from asymptomatic seedlings. It was concluded that heat injury which occurred during the spring when tissues were sensitive was the most likely cause of seedling mortality.

INTRODUCTION

Western larch (Larix occidentalis Nutt.) seedlings are an important crop, and several thousand are grown in containers each year at the Champion Timberlands Nursery in Plains, Montana. The 1986 crop was sown in mid-April in styroblock containers. Very little damping-off was encountered, although preventative applications of fungicides were made during seed germination and seedling emergence. In early June, extensive seedling mortality became evident. Affected seedlings were scattered throughout individual trays, rather than being concentrated in groups. Some seedlings were bent over, although most remained upright after death (figure 1). Tissue necrosis generally proceeded from the bottom whorl of needles upward through the seedling crown.

Growers initially thought the cause of mortality was Fusarium root disease because symptoms were similar and the disease had commonly occurred at the nursery (James 1986b). Therefore, several applications of benomyl (Benlate®) and Banrot® (combination of terrazole and Topsin M) were made to reduce further mortality. However, losses continued to occur and assistance to determine the cause(s) of mortality was requested from Cooperative Forestry & Pest Management.

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Due to budgetary constraints, only a limited number of photos were available.

Figure 1.--Containerized western larch seedling mortality from the Champion Timberlands Nursery, Plains, Montana. Seedlings were approximately 7 weeks; some affected seedlings (center) were bent over as tissue necrosis proceeded.

METHODS

One styroblock tray with 160 seedlings, some of which were dead or dying, was sampled to determine cause(s) of mortality. Each seedling was given a disease rating based on severity of foliage symptoms (table 1). This rating system was initially designed for seedlings infected with Fusarium root disease and worked well for the seedlings in this investigation. At the same time, seedling height (mm) was measured from the groundline. Each seedling with a disease severity rating of 5 or greater was carefully removed from the container block, and its root system was thoroughly washed under tap water to remove soil particles. Pieces of randomly selected roots were then aseptically placed on a selective medium for Fusarium (Komada 1975). Number of root pieces sampled per seedling varied depending on the number available and ranged from 3 to 15. All plates with roots were incubated at about 22-24°C under diurnal cycles of cool fluorescent light for 5-7 days. Fungi emerging from incubated roots were identified (usually to genus). Seedlings not evaluated initially (June) for disease organisms (with less severe or no symptoms) were placed in a growth chamber (24°C - 12-hour diurnal fluorescent light schedule) and watered when required. Approximately 1 month later (July), several seedlings with disease symptoms were analyzed for presence of root fungi as described above. About 8 weeks later (late August), all remaining seedlings were rated again for disease symptoms and analyzed for presence of root fungi. Colonization by root fungi was calculated on the basis of percent of seedlings sampled and percent of root system colonized.

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Table 1.--Foliage symptom severity ratings for containerized western larch seedlings at the Champion Timberlands Nursery, Plains, Montana.

Rating	Description
0.	No foliage chlorosis or necrosis.
1.	A few needles displaying tip necrosis, mostly concentrated in the upper crown.
2.	The lower whorl of needles partially or completely necrotic; remainder of foliage green and seedling upright.
3.	Most needle tips displaying necrosis; more than one-half of the crown affected.
4.	At least one-half of the crown necrotic; seedling upright.
5.	At least one-half of the crown necrotic; seedling tip bent over.
6.	At least three-fourths of the crown necrotic; seedling upright or with tip bent over.
7.	Seedling crown entirely necrotic; seedling upright or with tip bent over.

Since cause of seedling mortality was initially thought to be root disease, seed were sampled for presence of pathogens (particularly Fusarium spp.). Three hundred larch seed from a representative seedlot were placed directly on the selective Fusarium medium (Komada 1975) and incubated as described above. Percent of seed colonized by Fusarium and three other fungal genera (Penicillium, Alternaria, and Trichoderma) was calculated.

RESULTS AND DISCUSSION

Of the 160 seedlings examined in June, 120 (75 percent) had some level of disease symptoms manifested as foliar necrosis (table 2). Twenty-five percent of the seedlings were either dead or very near death (ratings 5-7). Seedlings with more severe disease symptoms were generally shorter than those without or with less severe symptoms. This may indicate either growth reduction effects or that the seedlings were dead or severely damaged for some time prior to analysis.

Table 2.--Summary of foliage symptom severity ratings in June, 1986 for containerized western larch seedlings at the Champion Timberlands Nursery, Plains, Montana.

Rating[1]	Number of seedlings	Percent of seedlings	Avg. height (mm)	Range of height (mm)
0	40	25.0	37.5	25-54
1	53	33.1	35.2	24-46
2	6	3.8	23.2	18-30
3	12	7.5	33.4	25-49
4	9	5.6	31.3	24-40
5	8	5.0	21.6	8-34
6	6	3.8	17.0	8-25
7	26	16.2	10.9	5-20
Totals	160	100.0	29.7	5-54

[1] See Table 1 for descriptions of ratings.

Results of isolations from seedling roots are summarized in table 3. Eight different genera of fungi were isolated from roots. The most frequently isolated fungi included Trichoderma and Alternaria. These organisms were found on roots during each of the three isolation periods and were probably saprophytic colonizers of roots. Other less commonly isolated fungi included Aureobasidium, Cylindrocarpon, Penicillium, Phoma, and Pythium. None of these were isolated with the consistency to implicate them as pathogens.

Fusarium spp., initially the suspected pathogens, were not isolated from severely damaged seedlings during the first series of isolations in June (table 3). However, these fungi were isolated from several seedlings during August, even some which lacked disease symptoms. Two general "groups" of fusaria were isolated. Fusarium oxysporum Schlect. was the most common species encountered. Several species of the "roseum" group were also isolated, but less frequently. However, neither of these groups was likely the cause of seedling mortality. They may have colonized seedling roots as either saprophytes or facultative parasites (Gordon 1965; James et al. 1986), but were not consistently associated with seedling mortality.

Results of isolations from larch seed (table 4) showed relatively low levels of Fusarium spp. on seed, although debris associated with seed (resin, wings, cone scales, etc.) were colonized by these fungi to a much greater extent. Such low rates of seed infection would probably account for little seedling damage by Fusarium-caused damping-off or root disease (James 1986a).

Table 3.—Occurrence of fungi on the roots of containerized western larch seedlings at the Champion Timberlands Nursery, Plains, Montana

Rating[1]	Date of isolation	No. of seedlings	Alternaria		Aureobasidium		Cylindrocarpon		Fusarium		Penicillium		Phoma		Pythium		Trichoderma	
			% Infect.	% Colon.[2]	% Infect.	% Colon.[2]	% Infect.	% Colon.[2]	% Infect.	% Colon.[2]	% Infect.	% Colon.[2]	% Infect.	% Colon.[2]	% Infect.	% Colon.[2]	% Infect.	% Colon.[2]
0	8/86	23	18.2	12.5	9.1	80.0	4.5	20.0	22.7	50.0[3]	4.5	10.0	18.2	20.0	0	0	95.5	54.3
1	7/86	3	33.3	33.3	0	0	0	0	0	0	0	0	0	0	0	0	100.0	44.4
1	8/86	31	43.5	31.0	0	0	0	0	47.8	47.3[3-4]	0	0	8.7	50.0	8.7	55.0	91.3	61.4
1	Subtotal	34	42.3	31.1	0	0	0	0	42.3	47.3[3-4]	0	0	7.7	50.0	7.7	55.0	92.3	60.1
2	7/86	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100.0	40.0
2	8/86	29	42.3	20.0	0	0	0	0	26.9	22.9[3-4]	0	0	3.8	20.0	3.8	20.0	92.3	67.1
2	Subtotal	30	40.7	20.0	0	0	0	0	25.9	22.9[3-4]	0	0	3.7	20.0	3.7	20.0	92.6	66.5
3	7/86	2	100.0	23.5	0	0	0	0	0	0	0	0	0	0	0	0	100.0	82.3
3	8/86	13	45.4	42.0	0	0	0	0	27.3	36.7[3]	0	0	0	0	18.2	45.0	90.9	74.0
3	Subtotal	15	53.8	37.3	0	0	0	0	23.1	36.7[3]	0	0	0	0	15.4	45.0	92.3	75.2
4	7/86	5	80.0	15.6	0	0	0	0	0	0	0	0	0	0	0	0	100.0	61.8
4	8/86	6	50.0	55.0	0	0	0	0	83.3	16.7[3]	16.7	10.0	16.7	10.0	16.7	30.0	83.3	76.7
4	Subtotal	11	66.6	30.8	0	0	0	0	33.3	16.7[3]	11.1	10.0	11.1	10.0	11.1	30.0	88.9	68.8
5	6/86	8	87.5	31.5	0	0	0	0	0	0	0	0	0	0	0	0	100.0	87.7
6	6/86	6	83.3	37.5	0	0	0	0	0	0	0	0	0	0	0	0	83.3	81.4
6	8/86	1	0	0	0	0	0	0	100.0	60.0[3]	0	0	0	0	0	0	100.0	40.0
6	Subtotal	7	71.4	37.5	0	0	0	0	14.3	60.0[3]	0	0	0	0	0	0	85.7	73.6
7	6/86	26	92.3	45.6	11.5	23.5	0	0	0	0	0	0	0	0	0	0	84.6	73.5
7	7/86	3	33.3	40.0	0	0	0	0	0	0	0	0	0	0	0	0	100.0	67.8
7	8/86	2	0	0	0	0	50.0	10.0	0	0	0	0	0	0	100.0	70.0	100.0	50.0
7	Subtotal	31	80.6	45.4	9.7	23.5	3.2	10.0	0	0	0	0	0	0	6.4	70.0	87.1	70.6
-	TOTALS	160	53.1	32.7	3.3	54.0	1.3	15.0	19.1	38.3	1.3	10.0	5.6	26.2	5.2	46.2	91.6	66.3

[1] See Table 1 for descriptions of ratings.
[2] Percent of the infected root system colonized by particular fungus.
[3] Colonized by Fusarium oxysporum.
[4] Colonized by Fusarium "roseum".

Table 4.--Occurrence of fungi on western larch seed and sod debris from the Champion Timberlands Nursery, Plains, Montana.

	Percent colonization			
No. seed surveyed	Penicillium	Alternaria	Trichoderma	Fusarium
300	85.7	67.3	2.7	1.7
No debris pieces 13	92.3	53.8	7.7	30.8

This investigation showed a lack of consistent association between root colonization by potentially pathogenic fungi and seedling decline and mortality. Therefore, cause of larch seedling mortality was probably not pathogens, but rather related to abiotic factors of stress within the greenhouse environment. During May 1986, after a prolonged period of cool, overcast weather, a sunny warm period occured. During this time, ambient air temperatures increased dramatically. As a result, young, recently emerged larch seedlings may have been damaged, especially if greenhouse temperatures were much higher than those outside.

Damage to young larch seedlings as a result of this unusual hot spell in May was reported at nurseries in Moscow and Lewiston, Idaho (James 1986c). Therefore, similar damage may have occurred at the Champion Timberlands Nursery. Damage may have resulted when cambial necrosis occurred at or near the groundline where temperatures exceeded lethal extremes. Effect on seedlings may have varied depending on stage of development; i.e., degree of tissue lignification and location within the greenhouse. Damaged seedlings may have appeared healthy for a considerable period of time following heat injury, particularly because of continued exposure to high levels of nutrients and moisture inherent in greenhouse growing conditions. Pattern of seedling damage in trays and general lack of response to fungicide applications would also substantiate this hypothesis of involvement of abiotic factors.

If future damage is to be prevented, growers should closely monitor greenhouse temperatures in the spring when young tissues are especially succulent and sensitive to injury. If temperatures increase dramatically, young seedlings should be cooled with irrigation and/or air displacement using fans. Care should also be taken to limit fungicide applications during this time, as young larch tissues may be especially sensitive to chemical toxicity.

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